Connectrolyser Show & Tell

Rona Mitchell, UK Power Networks

Mark Turner, Hydrogenus

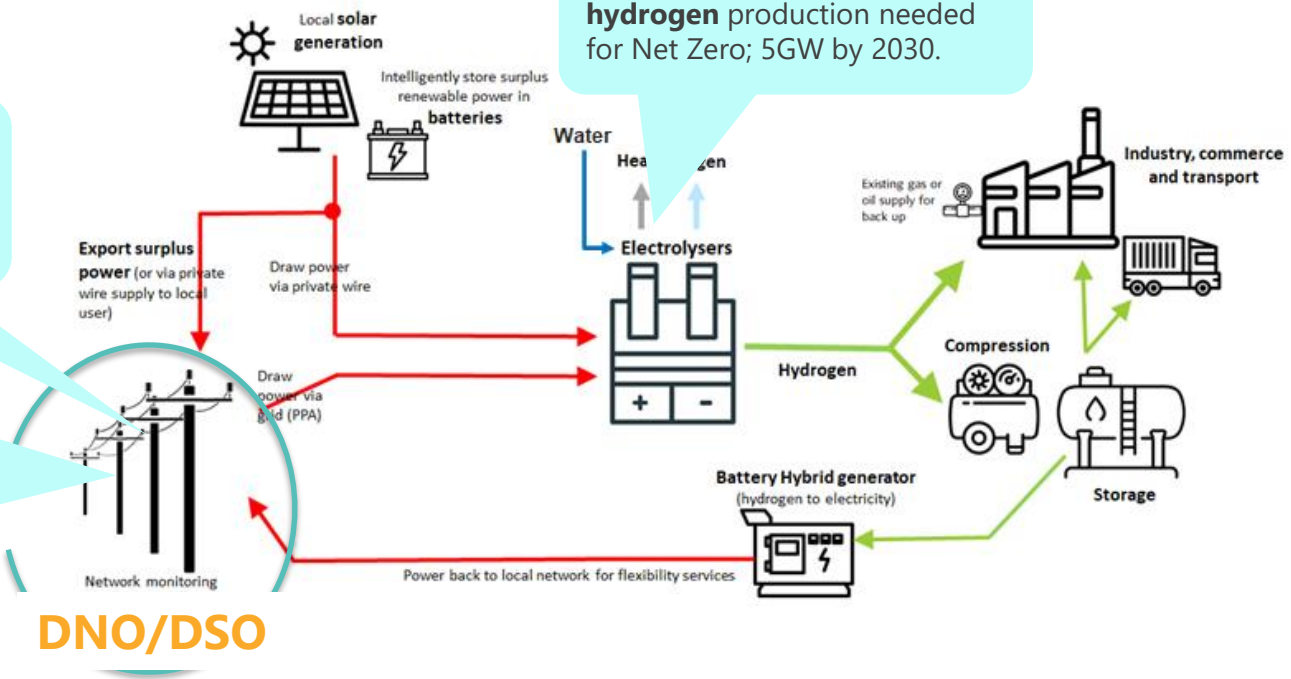
June 2023

The problem

Large scale, distributed **green hydrogen** production needed for Net Zero; 5GW by 2030.

Typical electrolyser deployments likely to require **substantial electrical connections** of 10MW+

Using **traditional firm capacity** connections to meet CfD aims is expected to exert pressure on networks. There will be high costs and long lead times.



Preparing to support low carbon energy systems by facilitating the rapid, cost effective connection of electrolyser ecosystems

Compelling financial and carbon benefits

National value of flexible hydrogen hub operation estimated to be worth up to:

- £30bn in avoided distribution network reinforcement (2050)
- £1bn/year in frequency response to the ESO
- 60TWh reduced renewable (transmission-connected) energy curtailment by 2030.

Carbon reduction:

- Direct link to amount of green H2 produced displacing
- Amount of renewables curtailment alleviated
- Avoid embodied carbon in network reinforcement

Collaborative working to deliver discovery

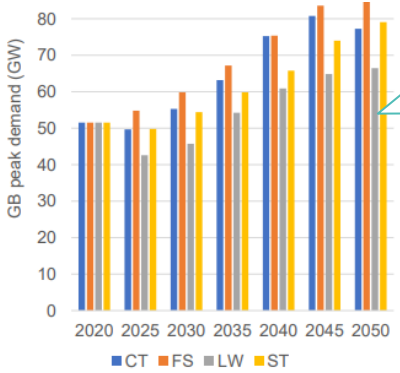
	Work package	Main parties	Activity
1	Hydrogen and electricity demand	HydroGenus, national gas, Imperial College London Consultants, ESC	Assessed the electricity demand for production of hydrogen to meet maximum daily demand of hydrogen and half-hourly production profiles to service a representative set of hydrogen off-takers at hydrogen hubs.
2	Network assessment	UK Power Networks	Assess capacity of existing distribution network to meet actual electrolyser ecosystem power requirements for connection.
3	Smart connection development	UK Power Networks, HydroGenus, Imperial College London Consultants	Review and assessment of connection and flexibility products available and their applicability to a hydrogen hub.
4	High level business case	HydroGenus, Imperial College London Consultants	Considered benefits of flexibility across GB distribution, including contribution to security of supply. Identified likely regulatory, technical and commercial constraints requiring further study in early part of Alpha.
5	Discovery Phase project management	HydroGenus	Ensure Discovery delivered on time, to budget and achieve outputs with all parties making the right contribution.

Key learnings from analysis of real-life situation

Hydrogen and electricity demand	• Hydrogen demand can be very peaky and sometimes unpredictable in the short term
Network assessment	• Unconstrained network connection likely to cost £20m+ compared to flexible, curtailable connection at nearer £13m. In line with average benefit of flex connection in ED1 is in range of £2- 22m dependent on situation
Smart connection development	• Various dynamic connection types available and all appear compatible with hydrogen hub • Some flexibility products appear more suitable for hydrogen hub operations • Updated Grid Code (P2/8) allows demand side services for security of supply
High level business case	• Potential high contribution of flexible electrolysis to security of supply and impact across GB • Key trade-offs with cost of electricity connection, ability of hydrogen hub to support the network, and value of on-site generation for network services • Some incompatibility between future Hydrogen CfD and flexible operation

Valuable modelling and analysis

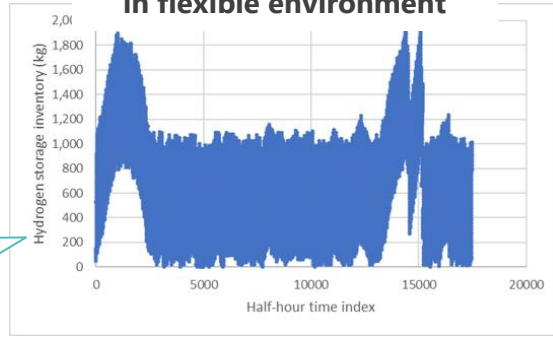
Impact of electrolyser uptake on GB peak demand



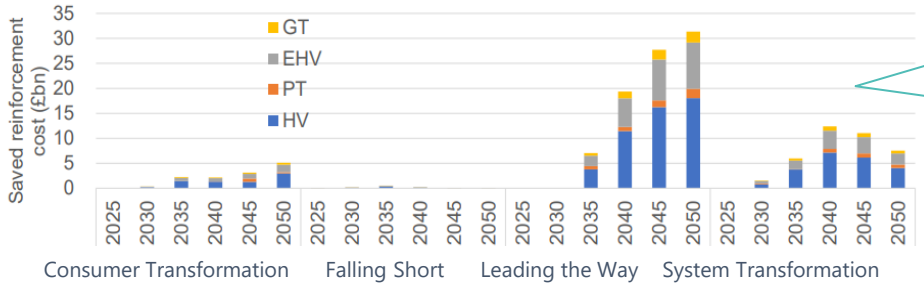
Peak demand on system may exceed 80GW in 2050 from current peak of 50GW

Electrolysers may contribute up to 8GW on distribution network and 40GW on transmission

Value of hydrogen storage in flexible environment

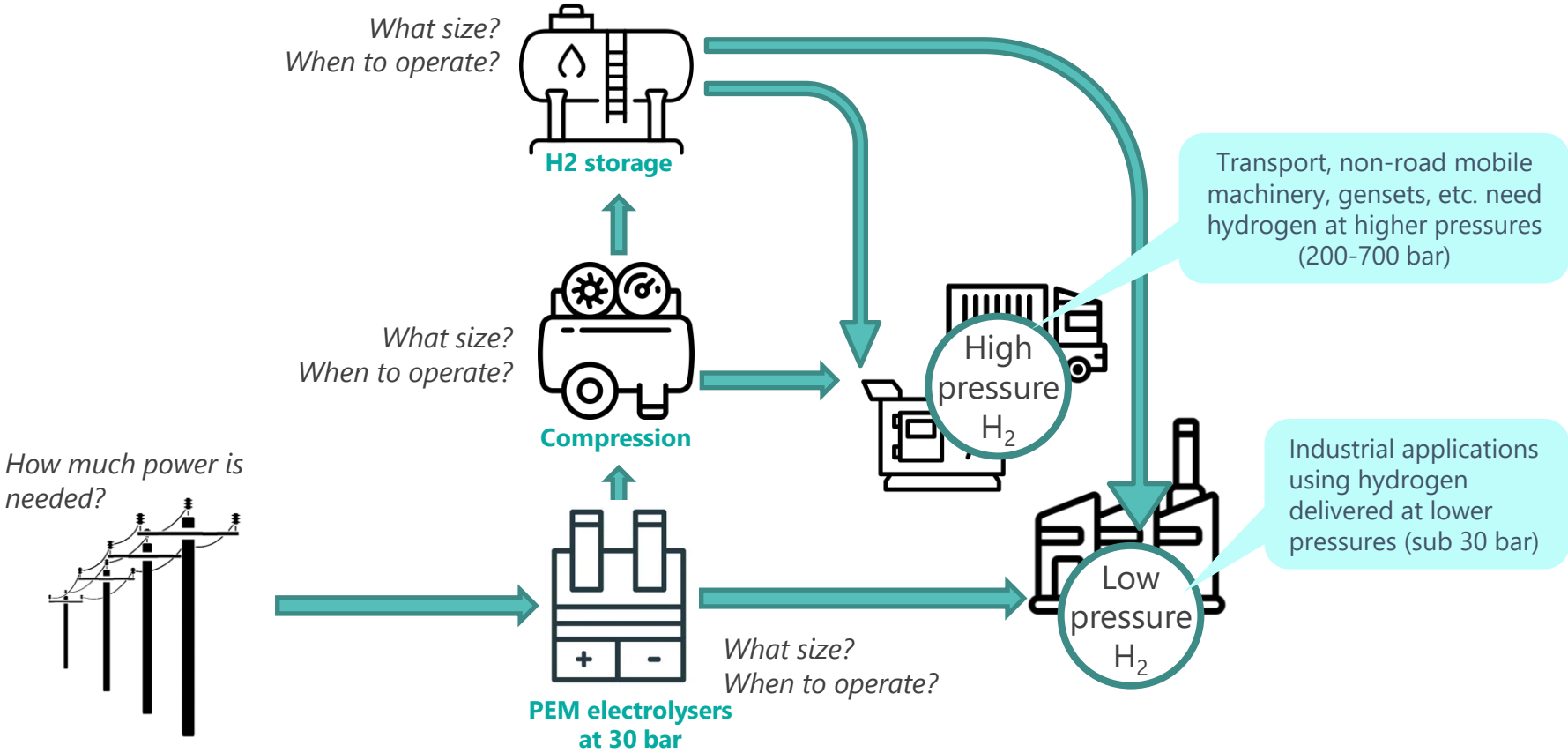


Hydrogen storage has a key role to play in unlocking the full potential of flexible electricity connections



Flexible hydrogen hub operation will save significant distribution network reinforcement costs for customers under different FES scenarios

Key questions for any hydrogen hub development



Explored collaboration with other SIF Discovery R2s

Interesting dialogues enabled us to understand respective projects:

- REACT, SHETL
- Artificial Forecasting, Northern Power Grid
- Integrated Hydrogen Transport Hubs, Wales and West Utilities
- NextGen Electrolysis, Wales and West Utilities
- HyCoRe, Northern Gas Networks
- And non-SIF: Carbon Trust led Integrator Programme

Whilst no obvious opportunities to collaborate were identified, we will review following these Show and Tells, if other projects could be complementary in future phases of Connectrolyser.

Discovery provided further clarity on the problem

Proton exchange membrane (PEM) electrolysers offer potential to exploit **flexible electricity distribution connections** which will benefit both the hydrogen producer and the DNO/DSO

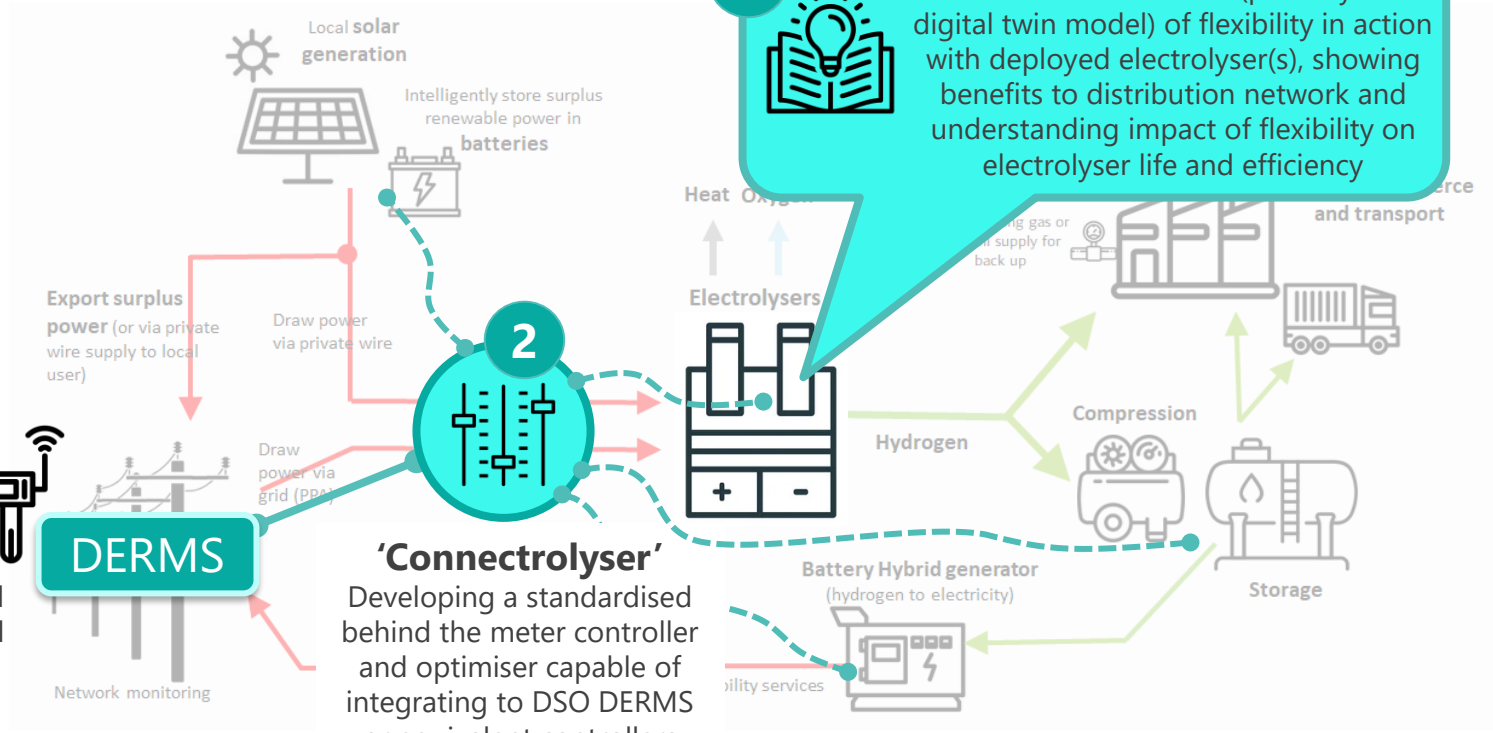
Operating flexibly with PEMs is unproven at scale

To make this norm, we collectively need to demonstrate in practice:

- Seamless integration and optimisation of control systems
- Impact of flexibility on PEM electrolyser life and efficiency
- Wider societal and customer benefits of a fully flexible, local energy system of renewable generation, electrolysers, storage and hydrogen to electricity power production

SIF based on the practical reality of a specific need emerging in East Anglia

Looking Ahead: Emerging view of Beta solution



Enhancements as required to DNO monitoring and control capability to exploit full value of electrolyser flex capability

'Connectroyser'
Developing a standardised behind the meter controller and optimiser capable of integrating to DSO DERMS or equivalent controllers

Puts DNOs on front foot in rapid and smooth deployment of electrolysers

UK Power Networks
Delivering your electricity

THANK YOU

Rona.Mitchell@ukpowernetworks.co.uk
Mark.Turner@hydrogenus.co.uk